

Learned and Innate behavior

What is learned behavior?

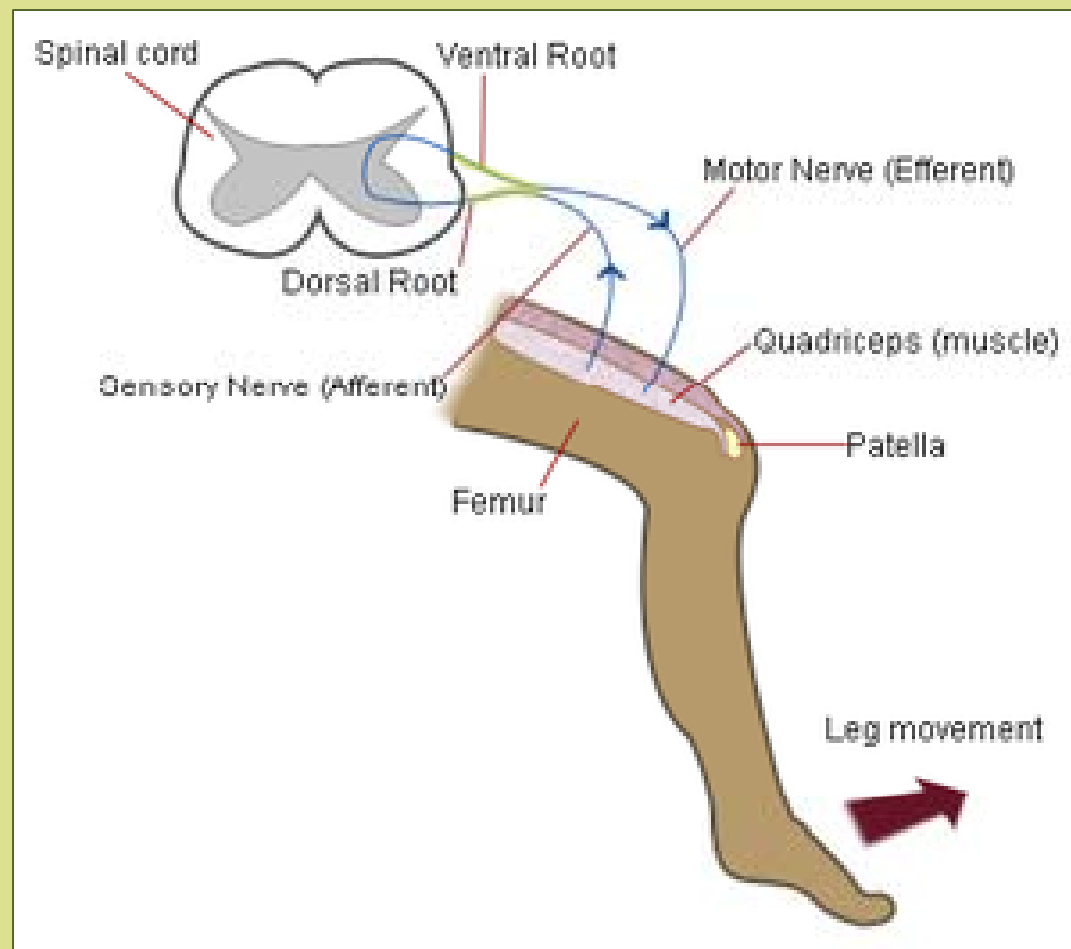
What is innate behavior?

What is innate behavior?

- Fixed
- Stereotyped
- No experience required

What is innate behavior?

- Knee-jerk reaction



innate behavior in animals

Brood-parasitic cuckoo and its host parent (Reed warblers)

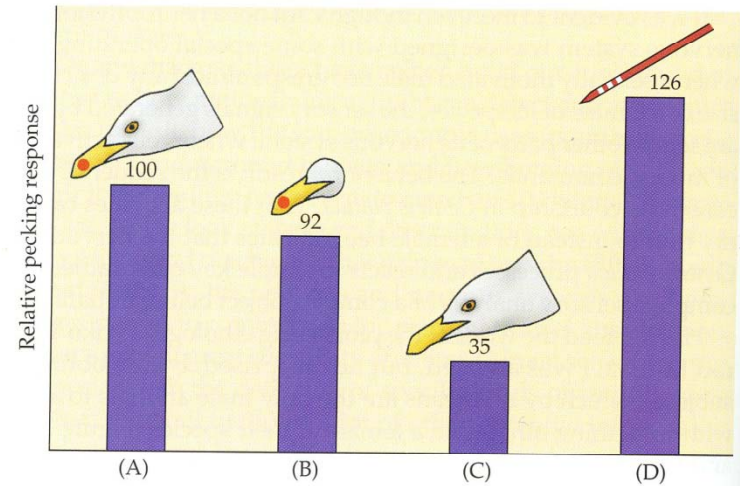
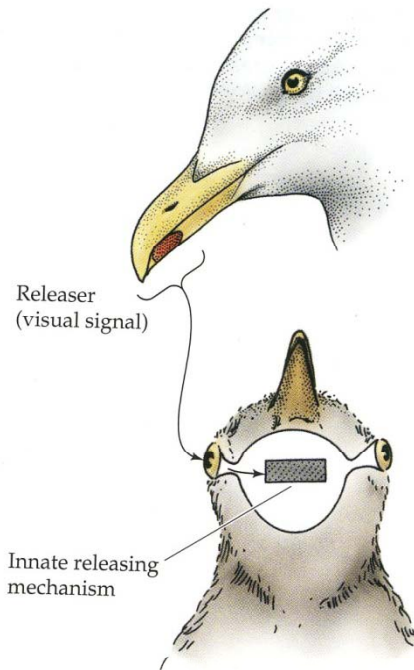


Egg-ejection

Innate behaviors sometimes require releasers (or sign stimulus)



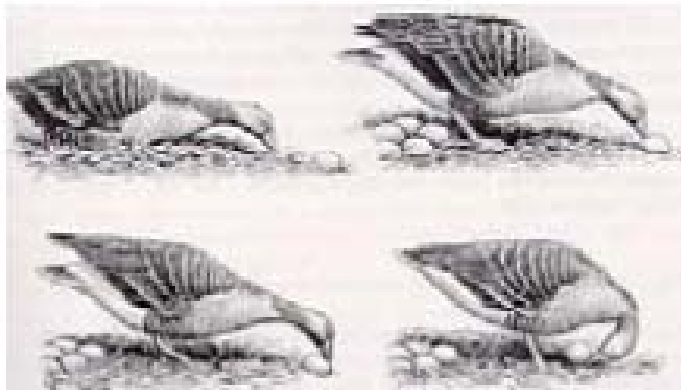
Herring Gull



Red spot (releaser) induces begging behavior

Fixed action pattern:
an **instinctive** behavioral sequence that is
indivisible and runs to completion

Egg-rolling in greylag geese
(Lorenz & Tinbergen, 1939)

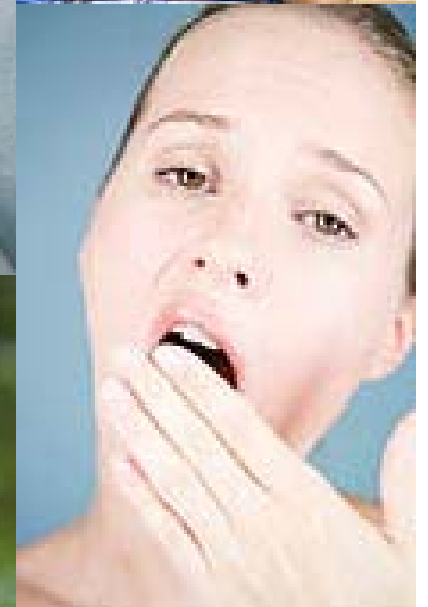


Graylag Goose



Goose continues to 'roll' egg into nest even
though egg has been taken away

Yawn triggers yawning



What is learned behavior?

- Modifiable (flexible)
- Experience-dependent
- Practice (error correction)
- Memory

What is learned behavior?



What is learned behavior?



Learned behaviors in animals:

Classical conditioning

Classical Conditioning: The Basics

In this video we'll introduce very basic concepts in classical conditioning by simulating Pavlov's experiments with dogs.

Learned behaviors in animals:

Operant conditioning

--reward, punishment

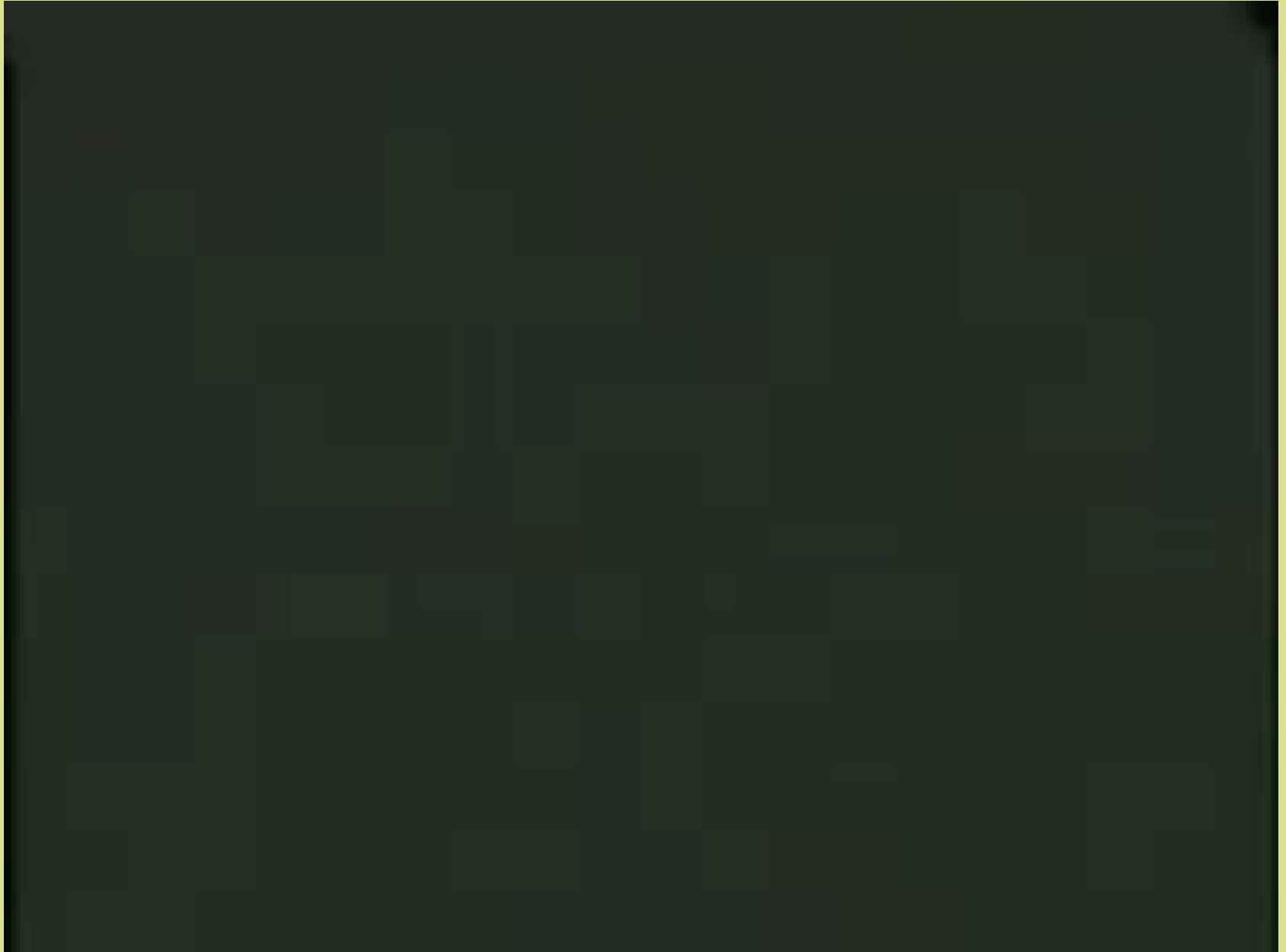
Learned behavior in animals:

Imprinting

(learning occurs at a particular age or life stage)

Filial imprinting and sexual imprinting

Filial imprinting (Konrad Lorenz)



Filial imprinting

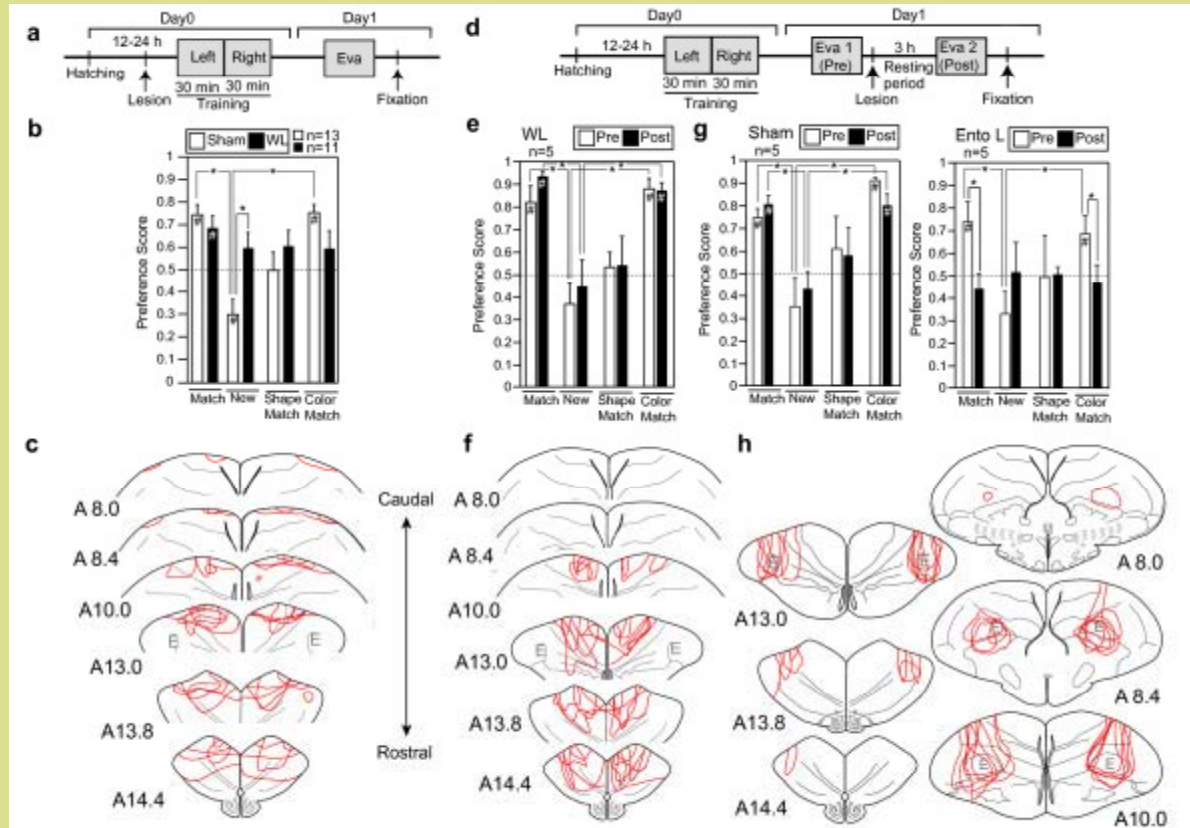
Proximate vs. Ultimate causes



Critical period (sensitive period)

Filial imprinting

Proximate vs. Ultimate causes

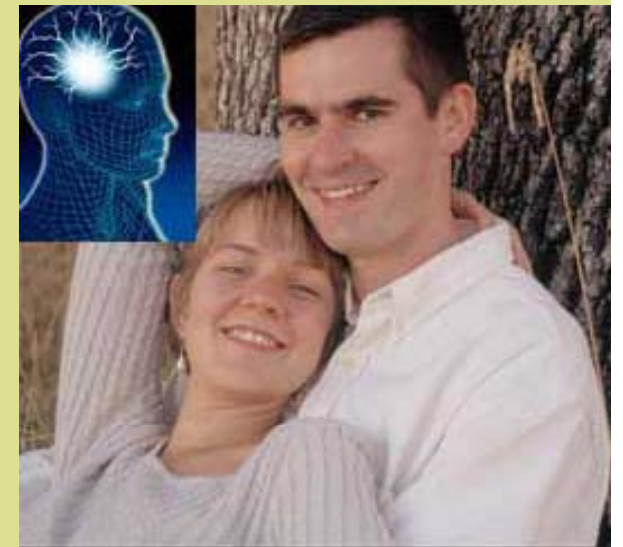


Sexual imprinting

Dad

Mom

Juveniles



Complex learning in animals: Tool-use by chimpanzees

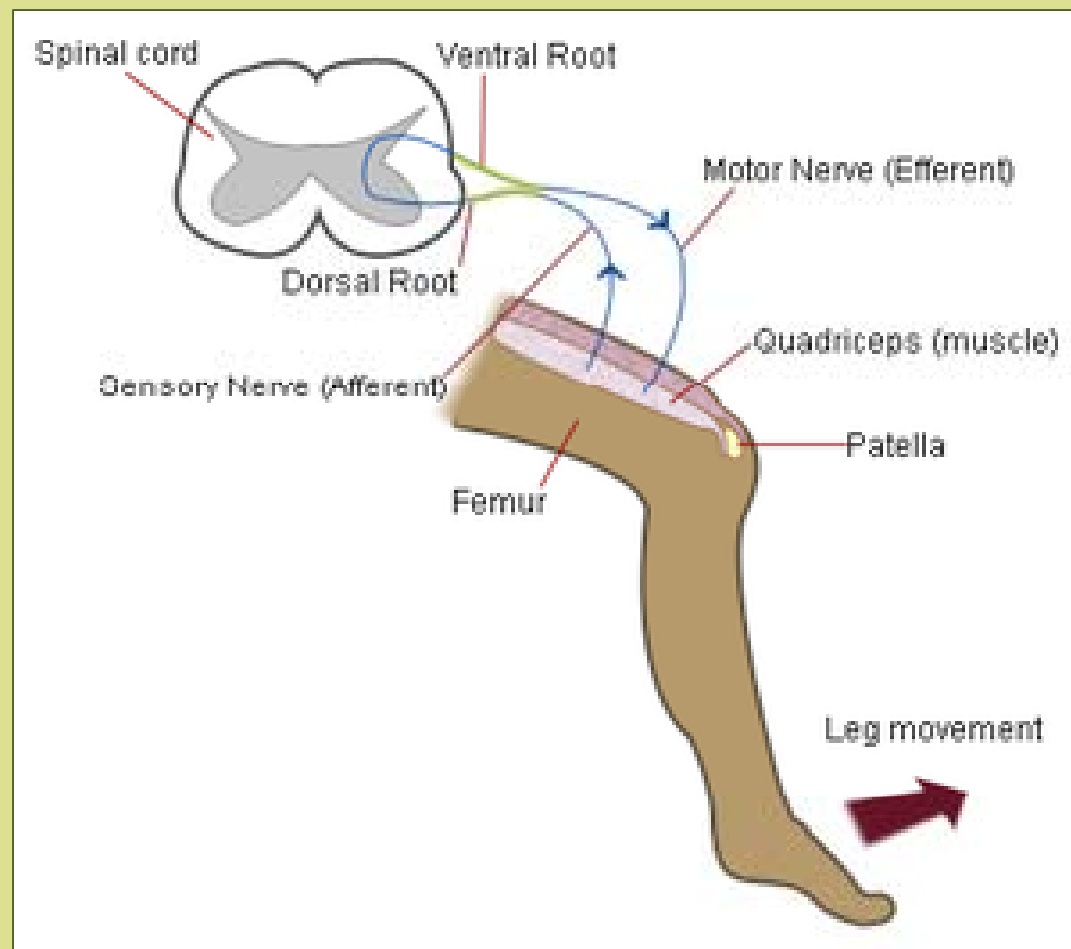


Most behaviors:

- Innate behavior can be modified (learned)
- Learning has innate basis

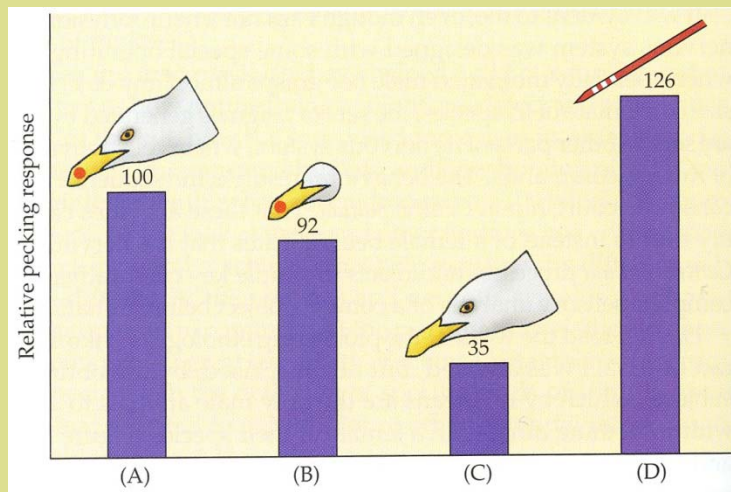
Innate behavior can be modified

- Knee-jerk reaction

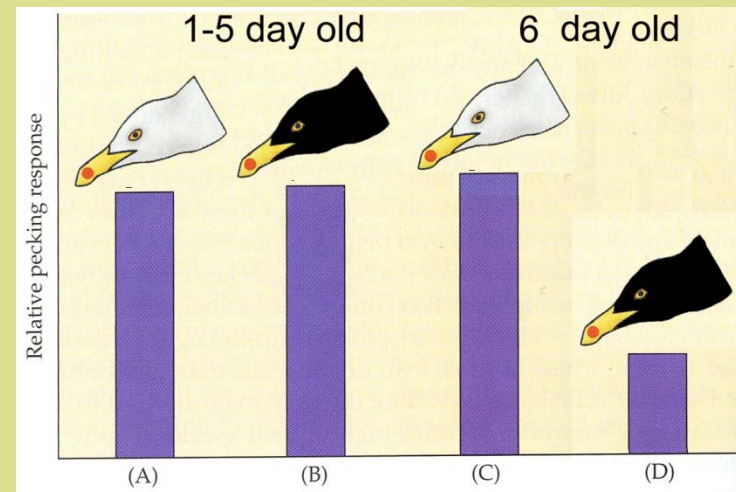


Innate or learned?

- Innate behavior can be learned.



Red spot induced innate begging



Jack Hailman (1967) : Newly hatched herring gulls do not distinguish between two models. However, at 6 days, they reliably tell the difference

Learned behavior has innate (genetic) basis



Case study:

Learned and innate vocalizations



Speech learning requires?

A few groups of mammals and birds evolve vocal learning

* Mammals

1. Humans
2. Cetaceans
3. Bats
4. Elephants

* Birds

1. Parrots
2. Hummingbirds
3. Songbirds

Only humans evolve spoken language

Speech learning requires

1. Vocal developmental process
(infant babbling):
2. Auditory experience
3. Sensitive period for learning
4. Specialized brain pathways

Speech learning requires development (error correction process)

Infant babbling



Babbling of a 1.5-year-old infant

“bow wow wow wow va wa....wee wee wee...

m hi daddy ba ma ba wow wa wa.... Den da daddy daddy!”

Kroodsma 1972

Speech learning requires auditory experience

In 1920, two girls, aged 8 and 18 months, were found by Rev. J.A.L. Singh in a cave in India, living with a family of wolves. Kamala was the older girl, and Amala was her infant sister. Like other children raised by animals, both girls growled, uttered sounds that were not speech, and had all the behaviors of their wolf caretakers.

How to test of auditory experience in learning language?

Speech learning has a sensitive period

Learning second language (Accent):

How to test of sensitive period in learning language?

Speech learning has a sensitive period

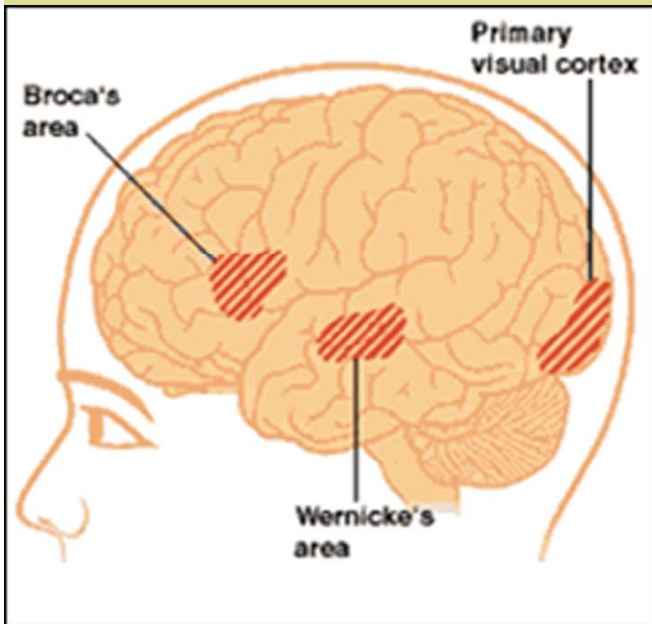
A 13-year-old girl name Genie was discovered in Los Angeles after a childhood of almost inconceivable horror. The daughter of a blind, abused mother and a paranoid and reclusive father, she had been kept in silence in a single room, mostly harnessed to a potty chair or confined in a caged crib. She was almost completely mute. As she was passed between scientists, foster parents, state officials. Today she learned much, her intelligence was high, her nonvocal communication was extraordinary, and her ability to solve spatial puzzles was ahead of her age.

But she never learned to speak. She developed a good vocabulary. But not elementary grammar, and syntax or word order was a foreign land.....

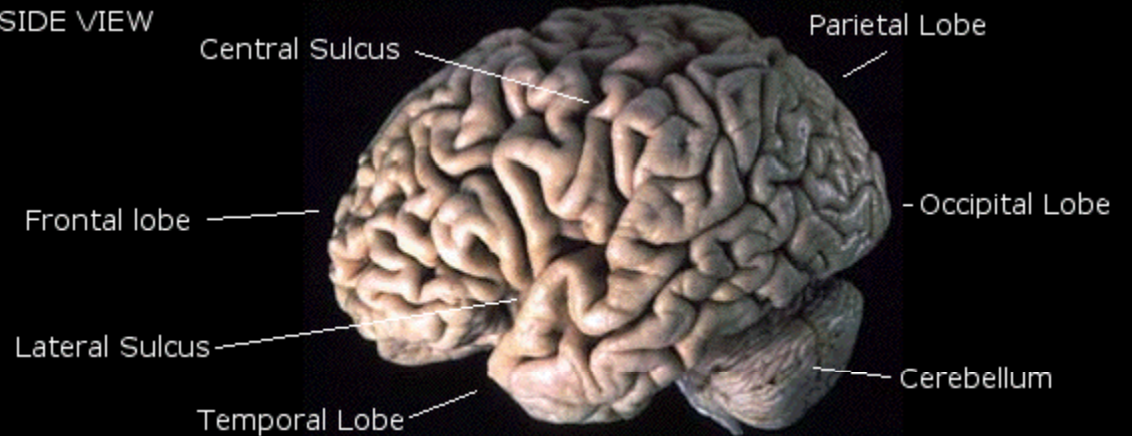
Speech learning requires

1. Vocal developmental process
(infant babbling):
2. Auditory experience
3. Sensitive period for learning
4. Specialized brain pathways

Speech learning requires specialized areas in forebrain

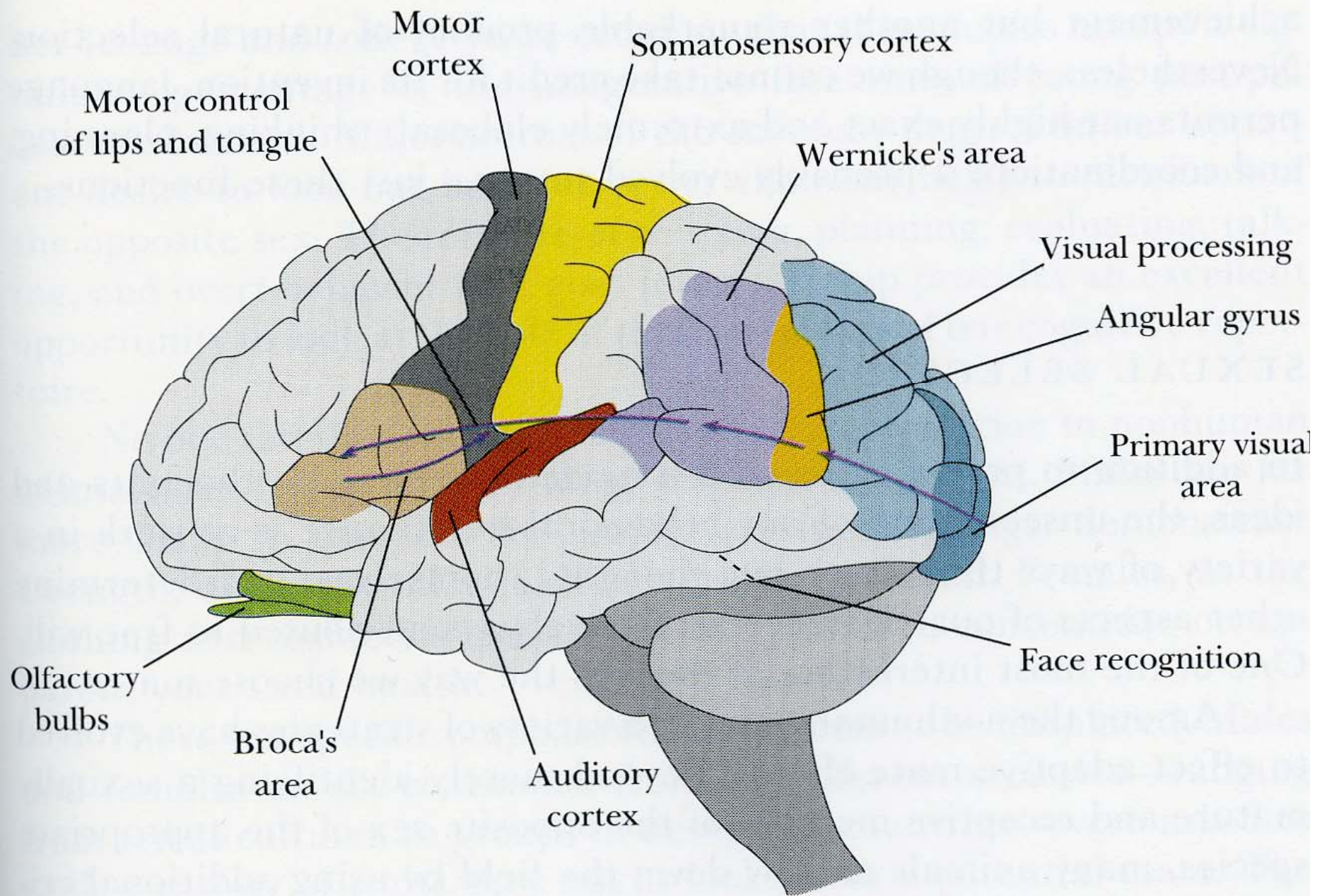


LEFT SIDE VIEW



Broca's area: speech production

Wernicke's area: understand speech



Birdsong: learned or innate?



A few groups of mammals and birds evolve vocal learning

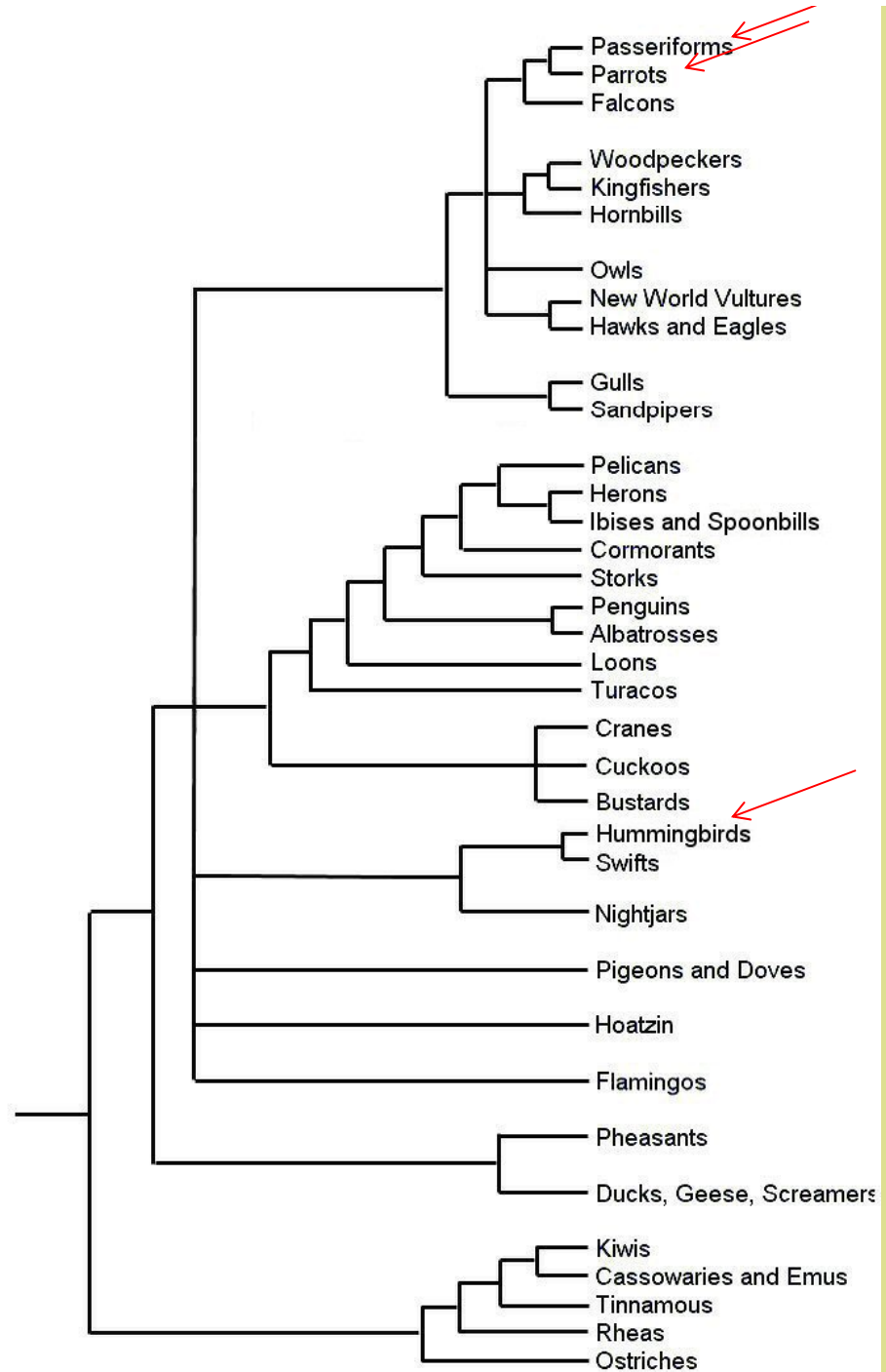
* Mammals

1. Humans
2. Cetaceans
3. Bats
4. Elephants

* Birds

1. Parrots
2. Hummingbirds
3. Songbirds

Vocal learning evolves in 3 groups of birds



Master of vocal imitation



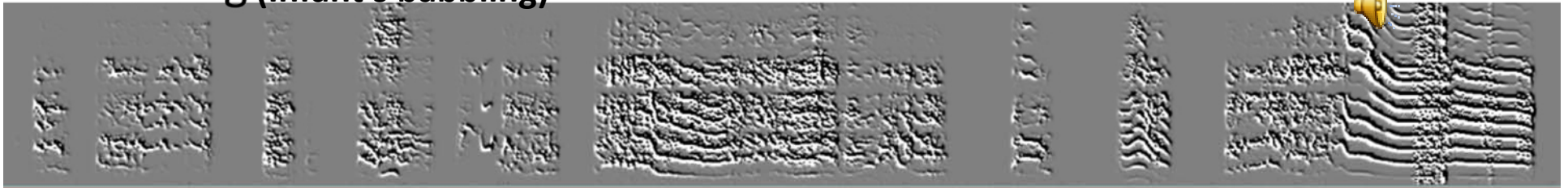
Superb Lyrebird

Birdsong learning requires

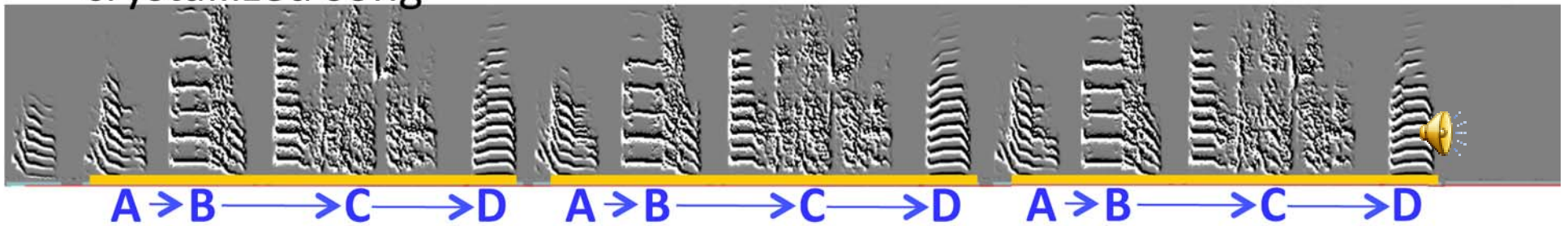
1. vocal developmental process
(babbling stage)
2. auditory experience
3. sensitive period of learning
4. specialized neural pathways

Birdsong learning requires a developmental process

subsong (Infant's babbling)



crystallized song

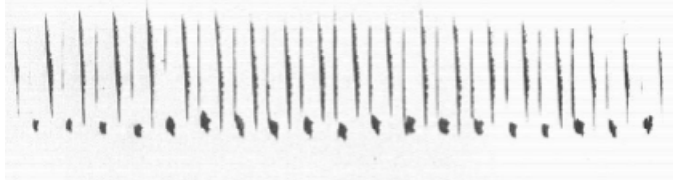


Zebra finch

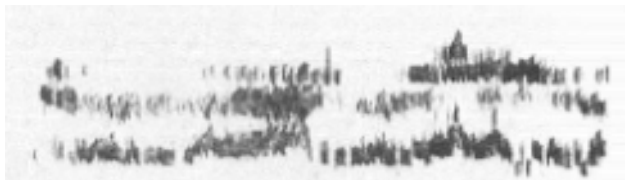
Birdsong learning requires auditory experience

bird's own sound (auditory feedback)

intact swamp sparrow

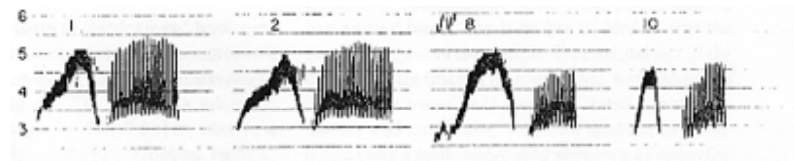


deaf swamp sparrow

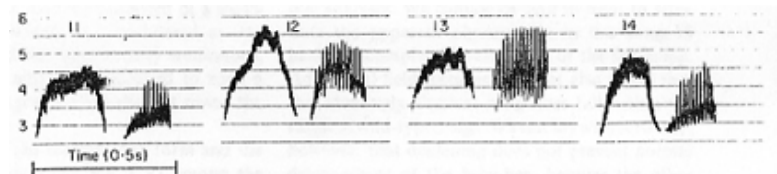


Oscines
Vocal learner

intact phoebe

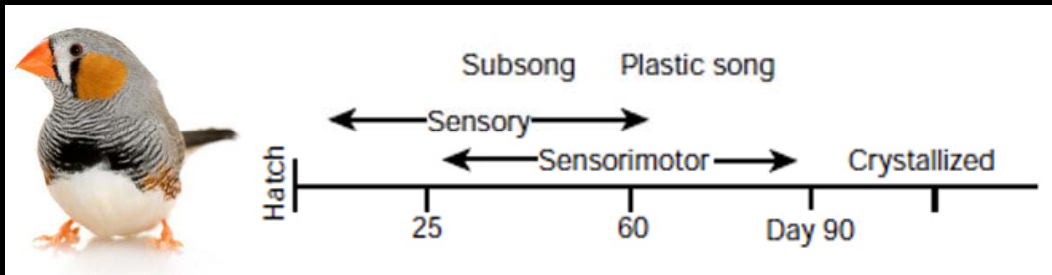


deaf phoebe

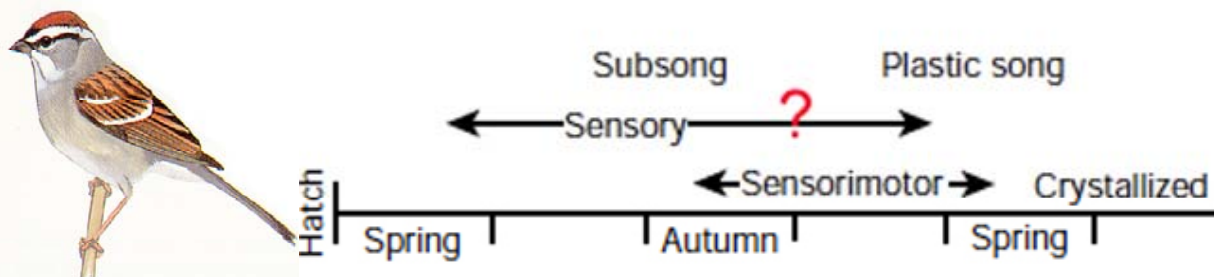


Suboscines
Non-learner

Sensitive period of birdsong learning occurs in early life

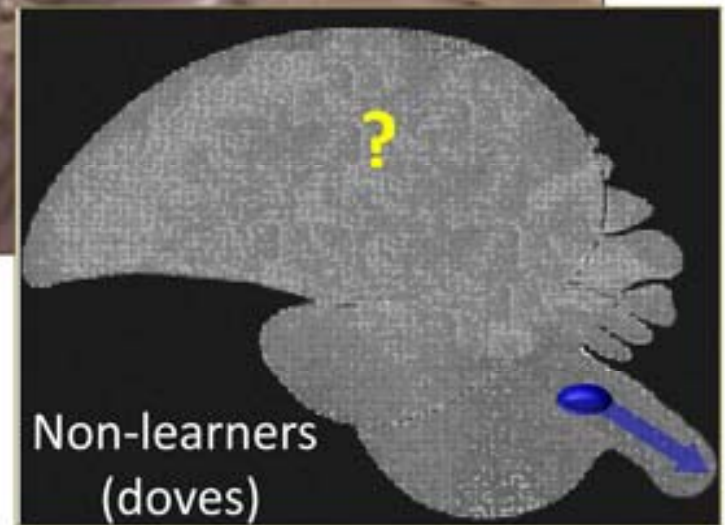
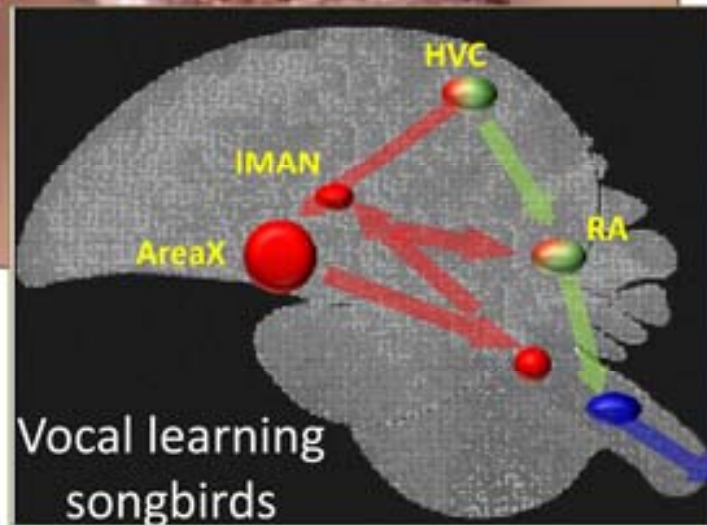


Non-seasonal
(zebra finch)



Seasonal
(chipping sparrow)

Birdsong learning requires specialized neural areas in forebrain



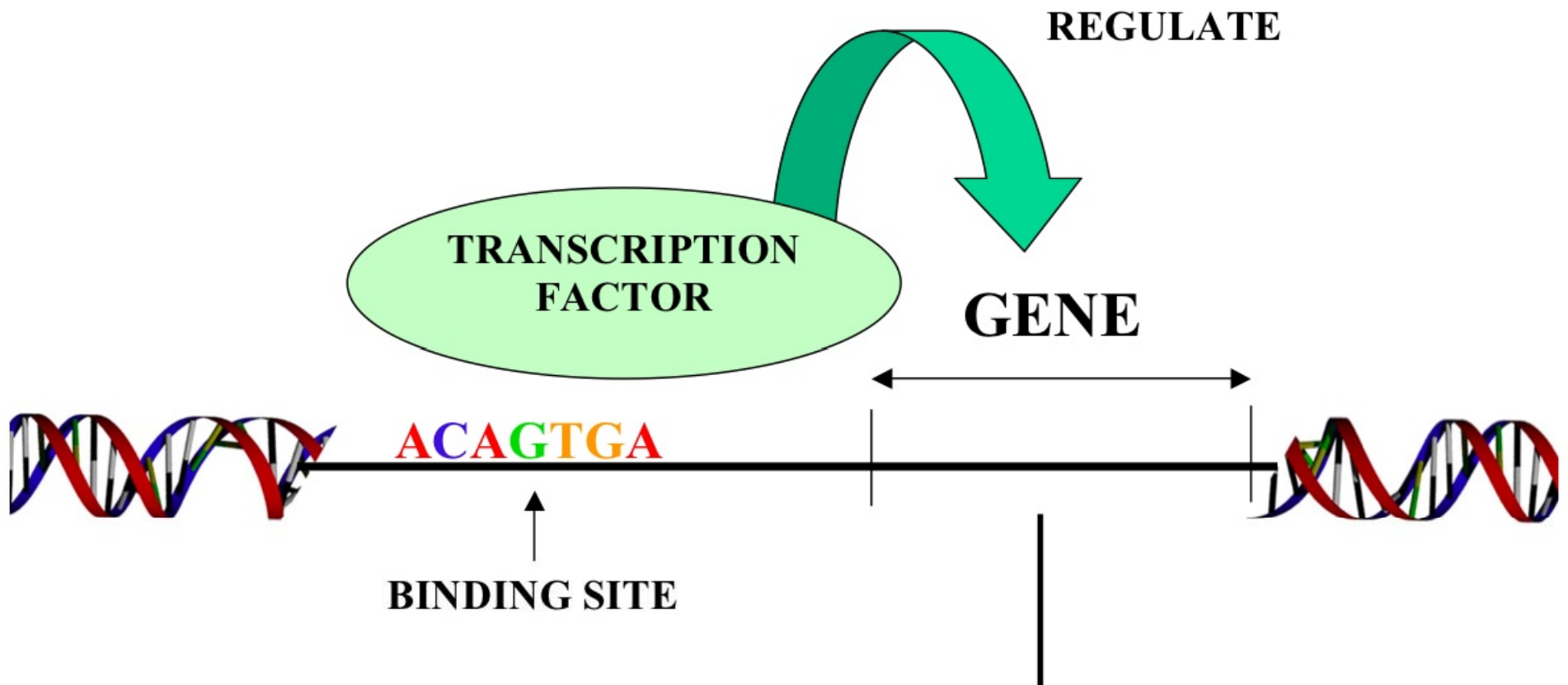
Genetic basis of vocal learning

FoxP2 gene: Forkhead box protein P2



FoxP2 is a gene coded for transcription factor

regulates the production of a protein from a gene.

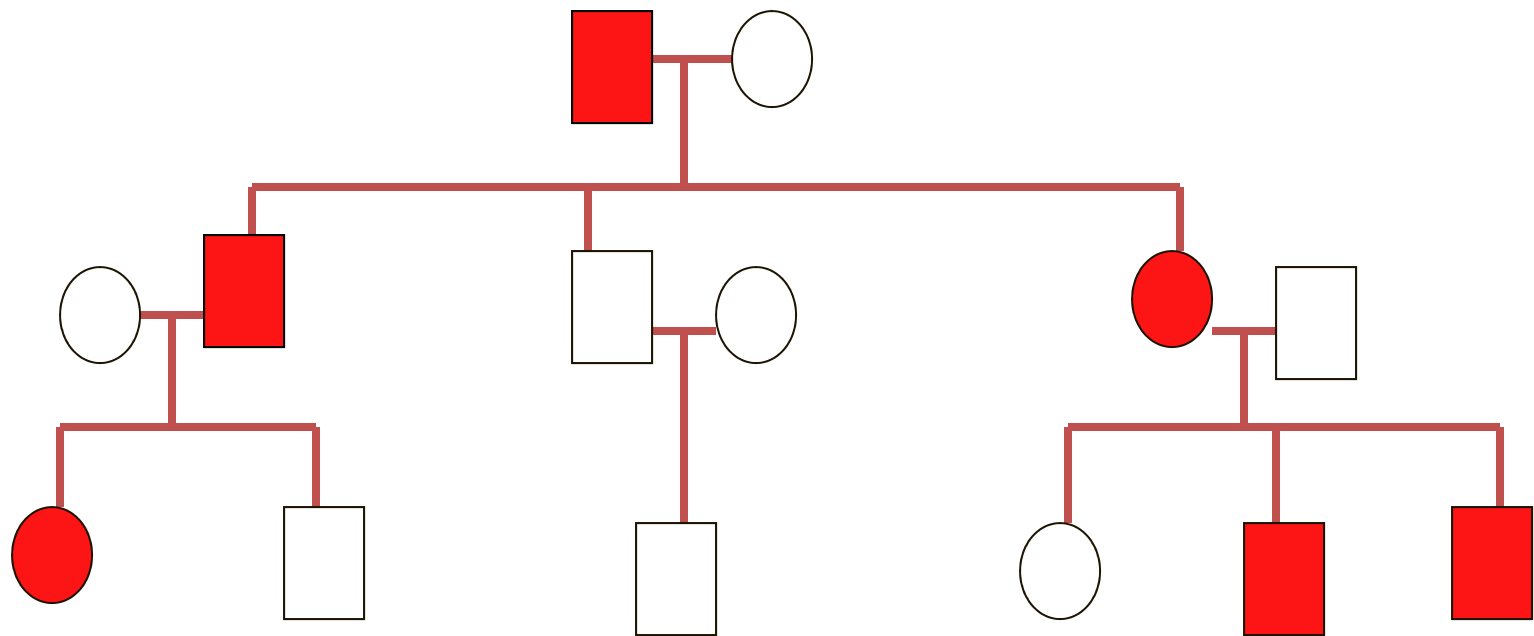


Q#2: FOXP2 protein is found in certain but not all brain cells in the same individual; how is this possible?

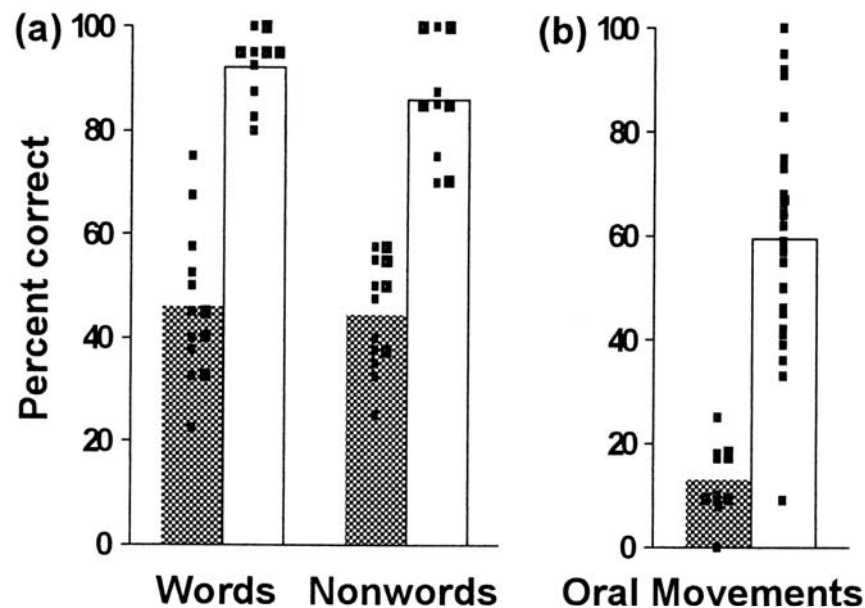
- A. Some brain cells don't have Chromosome 7.
- B. *FOXP2* DNA is only present in some brain cells.
- C. Some brain cells don't have ribosomes.
- D. *FOXP2* mRNA is only produced in some brain cells.
- E. Some brain cells contain more DNA.

Identification of the “speech gene” – *FOXP2*

The story: In 1990, scientists became interested in the KE family in London, half of whose family members have **speech disorders**.



Q#2: According to the KE family speech test results below, on which test(s) did the unaffected group do better than the affected group?



- I. Words
- II. Nonwords
- III. Oral Movement

- A. I
- B. I, II
- C. I, II, III
- D. I, II
- E. None of the above



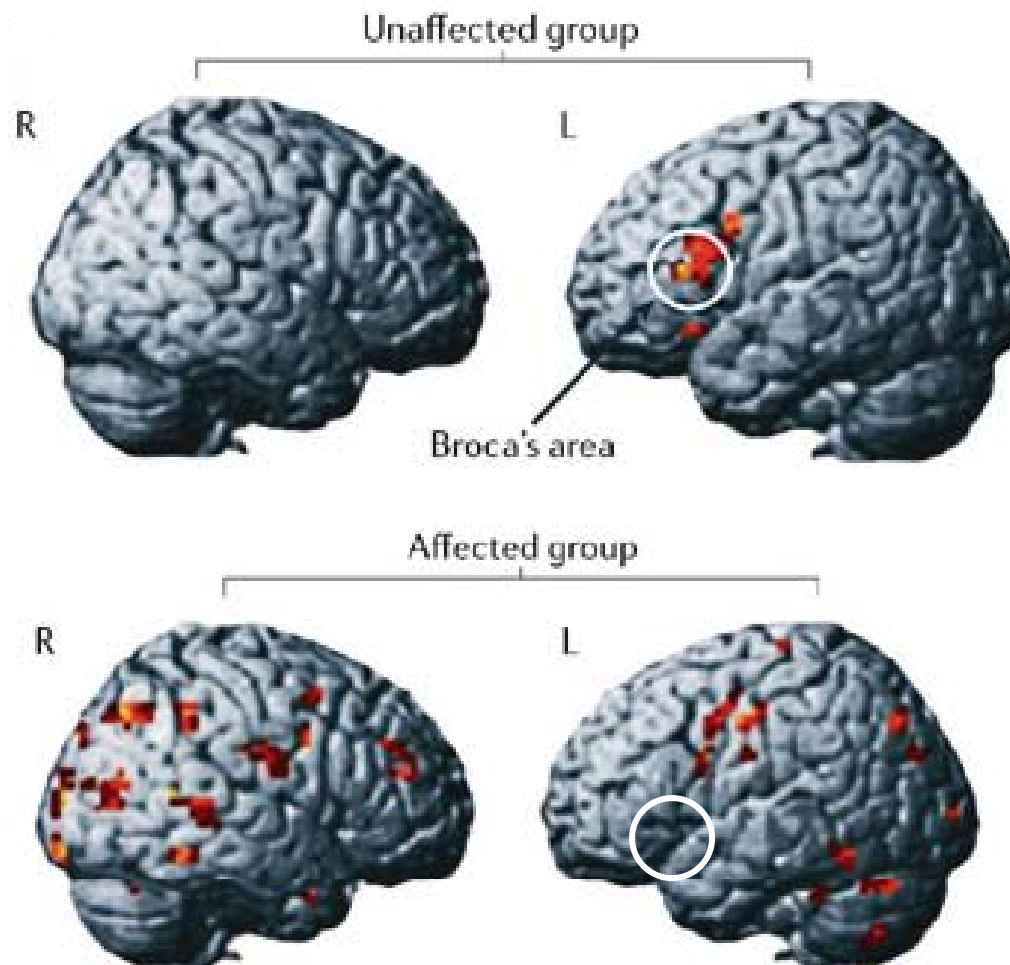
Affected group



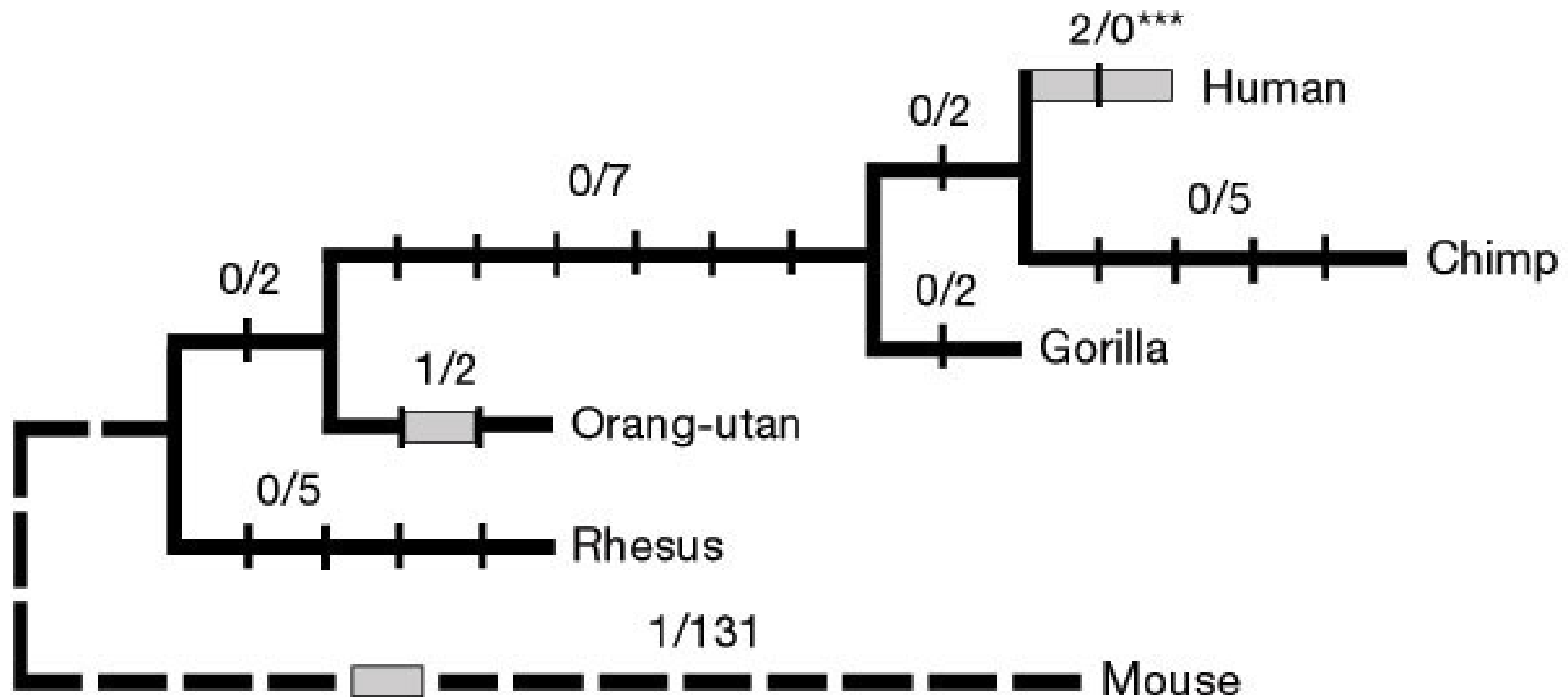
Unaffected group

Vargha-Khadem F et al. PNAS 1998; 95:12695-12700

Neuroimaging of the KE Family Members



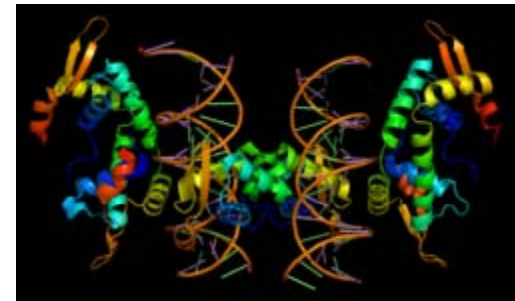
The mouse FOXP2 protein differs in just 3 amino acids from human beings!



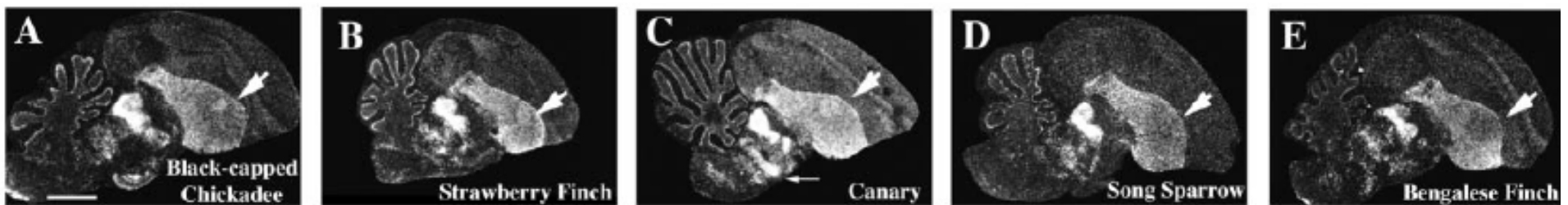
Grey Bars indicate amino-acid changes

FoxP2 and birdsong learning

FoxP2 gene: Forkhead box protein P2

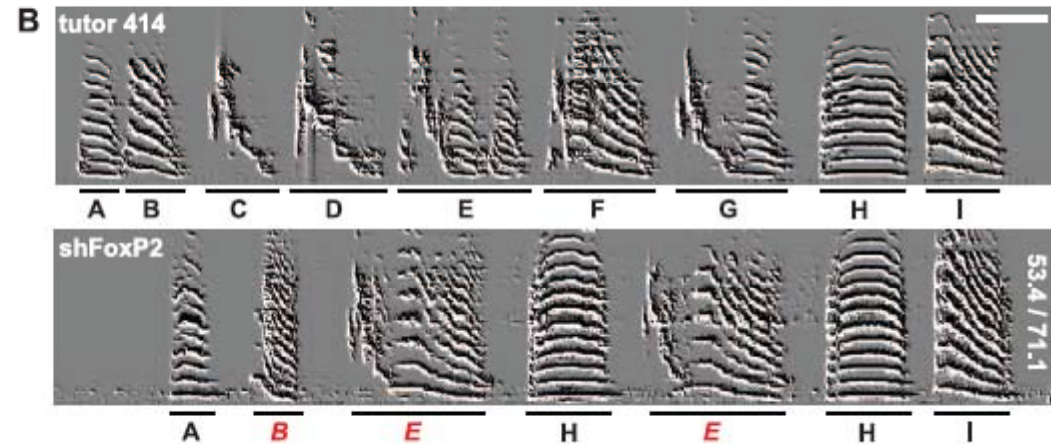
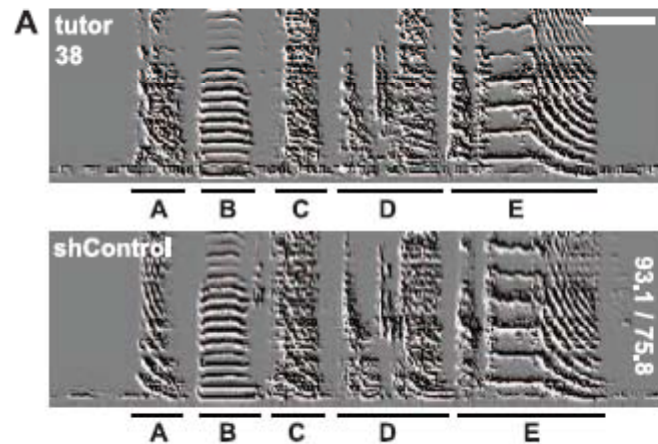
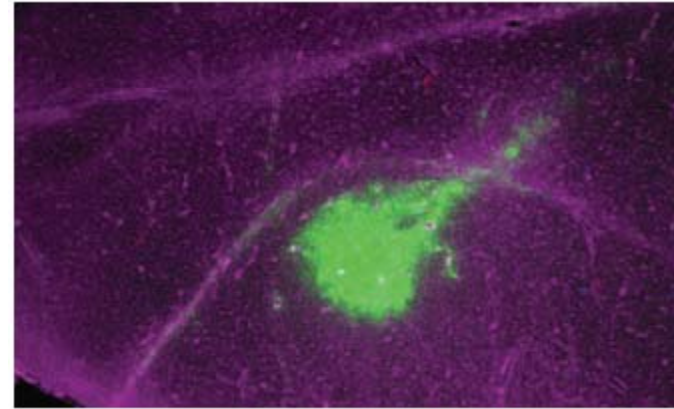
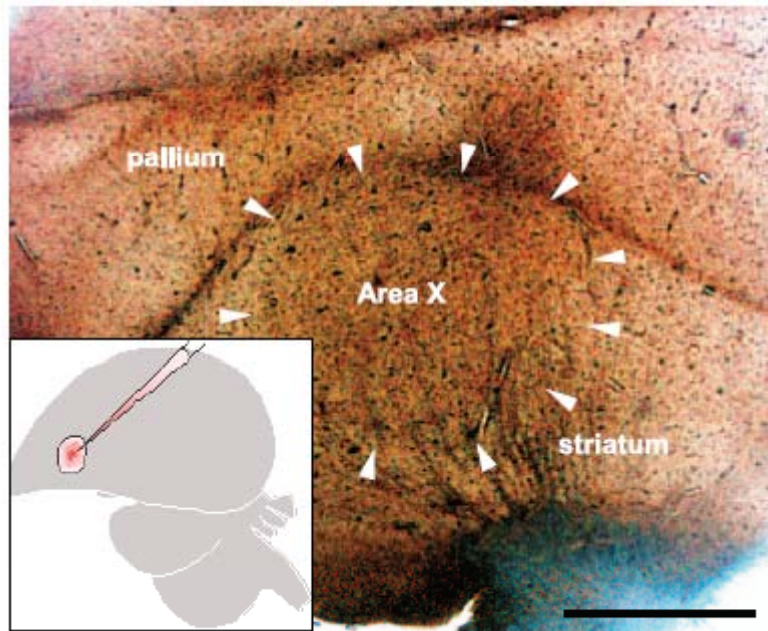


FoxP2 is highly expressed in a forebrain of songbirds



J.Neuroscience, 2004

RNAi knock down *FoxP2*



	Vocal learning songbirds	Vocal non -learning birds	Humans
Vocal development	Yes	No	Yes
Auditory experience	Yes	No	Yes
Specialized forebrain neural circuit	Yes	No	Yes
Affected by FoxP2	Yes	?	Yes

Final thought.....

Learning or instinct?

“all animals learn in fundamentally similar fashion”
Behaviorism (Pavlov; Thorndike)

“animals learn differently to best adapt to local
ecological environment
Ethology (Lorenz; Tinbergen)

Learning or instinct?

“ belief that gene determine morphological and behavioral traits and do so with little or no influence from environmental factors.”

“genetic determinism”

Learning or instinct?

“The organism was a black box that need not be opened: it merely processed signals from the environment into an appropriate response, adding nothing from its innate knowledge....”.

--B.F. Skinner

“environmental determinism”